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Volume X | December 1959 | Number 4

L'OPACIFICATION PAR VOIE CAROTIDIENNE DE L'ARTÈRE CÉRÉBRALE POSTÉRIEURE*

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L'opacification presque constante de l'artère cérébrale postérieure ipsilatérale à notre injection, quand celle-ci est faite au niveau de la carotide interne, nous a conduit à faire la révision des angiographies cérébrales pratiquées pendant les deux dernières années dans le Service de Radiologie de l'Hôpital Notre-Dame.

Anatomie

La première branche postérieure de l'artère carotide interne est la communicante postérieure. Elle naît juste au niveau de l'apophyse clinoide postérieure pour suivre un trajet presque horizontal sur une longueur de 1.5 cm. Après avoir fait une légère ondulation, elle se jette postérieurement dans la cérébrale postérieure, laquelle est une branche terminale du tronc basilaire. Une légère coudure met en évidence la jonction des deux artères (Fig. 1).

Figure 1 — Artère cérébrale postérieure normale; vue de profil.

La cérébrale postérieure se dirige en dehors en décrivant un arc de cercle autour de la face inférieure des pédoncules cérébraux, le long de la grande fente de Bichat. (Fig. 2.) Après avoir reçu la communicante postérieure elle se dirige vers la face inférieure du lobe occipital où elle se divise en ses branches terminales, généralement au nombre de trois:

a) une branche antérieure dirigée en avant à la face inférieure du lobe temporal qui irrigue la partie antérieure du lobe fusiforme et de la circonvolution de l'hippocampe.
b) une branche temporale postérieure qui irrigue la face inférieure du lobe temporal jusqu'à sa limite avec le lobe occipital.
c) une branche occipitale postérieure, la plus importante, qui pénètre dans la scissure calcarine et va se distribuer à la partie postéro-interne du lobe occipital, en particulier au lobe lingual et à tout le cunéus.

Avant de se diviser, l'artère cérébrale postérieure donne une série de collatérales destinées aux noyaux gris centraux et au mésencéphale et à la partie postérieure des plexus choroides ainsi qu'à la toile choroidienne.

Les artères inter-pédonculaires.
Les artères pédonculaires externes.
Les artères du corps genouillé.
Les artères des tubercules quadrijumeaux.
Les artères de la corne d'Ammon.
Les artères postéro-internes du thalamus.
Les artères choroidiennes postéro-latérales.
Les artères choroidiennes externes et moyennes.

Le système formé de la communicante postérieure et de la cérébrale postérieure irrigue aussi, par des branches en bouquet ou isolément, la face externe du tuber cinéréum, les tubercules mamillaires et la partie antéro-inférieure du thalamus ou couche optique.

* *Presented at Annual Meeting, The Canadian Association of Radiologists, January 11-14, 1959, Saskatoon.*

L'importance du territoire irrigué par ce système communicante postérieure-cérébrale postérieure, tant par sa pathologie inhérente que par sa symptomatologie clinique, exige du neuroradiologiste une connaissance approfondie de sa projection angiographique. (Figs. 1 et 2.)

Il sera intéressant de reconnaître la projection de ce système dans le cas d'engagement temporal à travers l'incisure tentorielle, (figs. 3 et 4) dans les cas de trouble visuel inhérent à la pathologie du lobe occipital, dans la cécité psychique et la pathologie thalamo-pédonculaire. Il sera utile également de reconnaître les variations anormales dans la pathologie des régions avoisinantes comme dans les tumeurs de l'angle ponto-cérébelleux ou les tumeurs hypophysaires.

Matériel

La révision de 332 artériographies carotidiennes consécutives pratiquées du 1er janvier 1956 au 1er août 1958, chez des sujets âgés de 3 à 60 ans, nous a fait constater que 150 fois l'injection avait été faite dans la carotide primitive, 12 fois dans la carotide externe et 170 fois dans la carotide interne.

Dès que nous nous sommes intéressés au problème de la thrombose de la carotide interne, ce qui nous ramène presque au début de notre pratique de l'angiographie, vers 1948, nous avons adopté comme technique de routine, d'inclure la presque totalité du cou sur nos films d'artériographies. C'est pour cette raison que nous pouvons à coup sûr déterminer le point d'injection du colorant puisque l'aiguille est toujours visible sur les films (fig. 1).

Cette technique est essentielle dans les cas de thrombose et comme il nous est arrivé de découvrir des thromboses insoupçonnées, nous l'avons appliquée à tous les cas. Le tableau suivant nous donne les pourcentages différents d'opacification de la communicante postérieure et de la cérébrale postérieure selon le point d'injection ou plutôt selon l'artère qui a été ponctionnée.

OPACIFICATION DES ARTÈRES

Injection dans	communicante post.	cérébrale post.	tronc basilaire (partie distale)
Carotide primitive 150	36 (24%)	31 (20%)	7 (4%)
Carotide externe 12	2 (16%) ?	2 (16%) ?	0
Carotide interne 170	136 (80%)	134 (79%)	39 (23%)

Figure 2 — Artère cérébrale postérieure; normale vue de face.

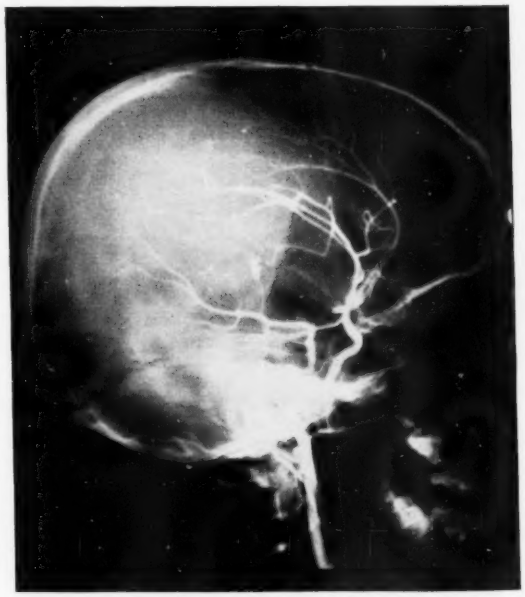

Figure 3 — Abaissement de la cérébrale postérieure dans un cas de tumeur temporale avec hernie.

Ce tableau illustre un fait certain: c'est que le système communicante postérieure-cérébrale postérieure s'injecte dans 24% des cas lorsque l'aiguille se trouve dans la carotide primitive, alors que ce pourcentage monte à 80% si l'aiguille est dans la carotide interne.

Figure 4 — Même cas que figure 3 — vue de face. A signaler le déplacement vers la ligne médiane de l'artère cérébrale postérieure.

Il semble donc que l'opacification de la cérébrale postérieure par voie carotidienne dépende en grande partie d'une technique précise qui vise à ponctionner la carotide interne.

Technique

Après la désinfection de rigueur, la plupart du temps sous anesthésie générale au Penthotal, une anesthésie locale est pratiquée avec blocage stellaire.

Une aiguille à ponction lombaire #17 à biseau long est utilisée pour aborder la carotide au niveau de la 5e vertèbre cervicale, 1 cm. au-dessus du tubercule de Chassaignac. Le jet artériel une pois perçu, l'aiguille est dirigée vers le haut dans la lumière de l'artère sur une distance d'environ 2 cms.

La progression de cette canalisation doit être surveillée en enlevant le mandrin de façon à contrôler la persistance du jet artériel, ce qui permet de contrôler la situation permanente de l'aiguille dans la lumière du vaisseau.

Cette manoeuvre amène habituellement l'aiguille à la hauteur de la 4e vertèbre cervicale, ou plus exactement à la bifurcation de la carotide primitive.

A ce moment, le biseau est tourné en avant et en dehors de façon que même si l'aiguille est au niveau de la bifurcation, la poussée de l'injection engage l'opacifiant dans la carotide interne. Nou avons constaté que la disposition du biseau joue un rôle important dans la technique. S'il se trouve collé contre la paroi artérielle, l'opacification est moins bonne lors de la première injection. Il suffit de tourner légèrement le biseau pour le décoller de la paroi.

Discussion

Certains auteurs[1,3] qui ont étudié ce problème avant nous, veulent que la cérébrale postérieure apparaisse uniquement dans le tiers (1/3) des cas d'injection de la carotide. Cette affirmation ne semble valable que si l'on ne tient pas compte du lieu de l'injection, puisque nous avons obtenu une opacification de la communicante postérieure dans 4/5 des cas d'injection de la carotide interne.

En effet, sur 150 injections de la carotide primitive, la cérébrale postérieure est opacifiée 31 fois alors que sur 170 injections de la carotide interne, cette même cérébrale postérieure s'opacifie 134 fois. Nous croyons que ce pourcentage de 20% d'échecs pourrait peut-être s'expliquer, au moins partiellement, par le fait que dans un certain nombre de cas, il existe une injection péri-vasculaire ou intra-murale, ce qui a pour effet de diminuer l'efficacité de l'injection.

Peut-être également que si nous avions toujours pris soin de tourner le biseau de l'aiguille pour diriger l'injection, le pourcentage de 80% de succès aurait été légèrement plus élevé.

Lindgren[2] est plus formel dans un travail antérieur, quand il donne un chiffre plus convainquant de visualisation de la cérébrale postérieure dans 2/3 des cas par l'injection faite dans la carotide interne.

Par contre, l'on a déjà avancé l'hypothèse que le remplissage de ce système s'expliquait par une hypotension comme facteur essentiel[4]. Cette hypotension, qui serait promptement réversible, serait due à une stimulation réflexe du sinus carotidien.

Vu que nous pratiquons systématiquement un blocage stellaire pour éliminer le vasospasme, nous ne croyons pas qu'il soit juste d'incriminer uniquement cette hypotension réflexe pour expliquer la fréquence avec laquelle nous obtenons l'opacification de ces vaisseaux.

Il nous semble en effet que la canalisation de la carotide interne soit plus importante que l'hypotension réflexe du sinus carotidien.

Un fait est évident: la même technique est toujours employée.

Quand nous sommes dans la carotide interne, la cérébrale postérieure s'injecte dans les 4/5 des cas, alors que si nous sommes dans la carotide primitive, cette même artère s'injecte uniquement dans 1/5 des cas.

Dans un cas comme dans l'autre, la stimulation réflexe devrait se faire.

Conclusion

En conclusion, la méthode d'opacification de la cérébrale postérieure nous semble intéressante dans tous les cas où nous soupçonnons une lésion expansive qui peut déterminer un engagement temporal, dans les cas de malformation vasculaire avec atteinte des muscles extrinsèques de l'oeil, dans les tumeurs de l'angle ponto-cérébelleux et dans toute pathologie du lobe occipital.

Summary

The neuroradiologist should be acquainted with the radiographic projection of the posterior cerebral artery because this vessel irrigates a rather important territory and because its abnormal position may reveal a temporal lobe herniation in many cases of supra-tentorial space-occupying lesions.

The posterior cerebral artery, being almost constantly filled when the dye was injected into the internal carotid artery, we decided to review all our cerebral angiograms done in the last two years.

We suspected that the puncture of the internal carotid was the main factor in visualizing the posterior cerebral artery in carotid angiography.

From January 1956 to August 1958, 332 carotid arteriographies were performed in our department.

As soon as we became interested in the problem of the internal carotid artery thrombosis, (that was in 1948) we adopted, as a routine procedure, the inclusion of the whole neck on the X ray film. We believed that it was essential to use this technic in cases of thrombosis, and as we found many cases of unsuspected thrombosis, we decided to use it in every cases.

For this reason we can determine very exactly, in almost all of our arteriograms, the point where the needle penetrates the artery because this needle is visible on the film.

Out of these 332 carotid arteriographies, 150 were done in the common carotid, 12 in the external carotid and 170 in the internal carotid.

The posterior communicating artery was visualized 36 times and the posterior cerebral artery 31 times when the injection was made into the common carotid artery.

When the external carotid was punctured (in these 12 cases) these same two arteries were visualized only twice.

When the internal carotid artery was punctured (170 cases) the posterior communicating artery was seen in 136 cases and the posterior cerebral in 134 cases.

With these figures we can conclude very definitely that the posterior cerebral artery is visualized in 20%-24% of cases when the common carotid is punctured and that this percentage goes as high as 79 to 80% when the internal carotid is punctured.

It seems then that the opacification of the posterior cerebral artery is dependent, in a great majority of cases, on a technic which tends to puncture the internal carotid artery. We have read many times in different articles by various authors, that the posterior cerebral artery is visualized only in one third of carotid arteriograms. This does appear to be true only if one does not take into account which artery is punctured, since, we opacified the posterior cerebral artery in four out of five injections into the internal carotid. We believe that some of the 20% failures to opacify the posterior cerebral, can be explained at least partially by a certain number of perivascular injections, in which case the injection is much less efficient.

To our knowledge, Lindgren is the only one to ever make a difference between common carotid, internal or external carotid arteries. He says that the posterior cerebral is visualized in 2/3 of cases when the injection is done in the internal carotid.

Another reason for this survey was that we were not convinced by the hypothesis that the filling of the posterior cerebral artery can be explained by an intracranial hypotension created by the stimulation of the carotid sinus.

We believe that the puncture of the carotid artery is much more important than this hypotension.

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TOTAL BODY RADIATION AND DOSE TO THE OVARIES FROM A THERAPEUTIC DOSE OF IODINE^{131}*

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Introduction

In recent years numerous radioactive isotopes have become available both for diagnosis and for therapy. The rapid increase in the clinical use of these isotopes has given rise to concern over the resulting radiation hazards to the patient, to hospital personnel, to patients in adjacent beds and to the patient's family if the patient is not hospitalized[3,4,5].

In this paper the radiation hazard to one particular female patient resulting from I^{131} therapy for hyperthyroidism is considered. We divide the hazard into two parts, namely, total body radiation, and dose to the ovaries. In both cases our sole concern has been to estimate the dose in rads. No attempt has been made to estimate the possible somatic or genetic damage resulting.

Case History

Miss M. G., age 47, was admitted on May 3, 1958, with a history of weight loss of 20 pounds in the previous six months. She had marked heat intolerance, showed moderate increase in sweating and complained of increasing tiredness and nervousness. Bowel habits were normal and there were no palpitations or dyspnea. Slight ankle swelling was present.

Examination showed a very thin patient weighing only 73.5 pounds. The skin was fine and flushed and there was bilateral exophthalmos with a left divergent strabismus. The thyroid gland was moderately enlarged with an estimated weight of 60 grams. The pulse was regular and 120 per minute, and the blood pressure was 160/60. There was a grade one systolic murmur over the entire precordium. There was bilateral quadriceps weakness.

Laboratory examinations showed a hemoglobin of 11.2 gm. per cent, white blood count 5700 cells per mm^3 with a normal differential count. Examination of urine was negative. The serum cholesterol was 167 mg. per cent. (The normal for this age and sex is 176 to 315 mg. per cent.) The BMR was +46 and +68. The 24-hour radioactive iodine uptake and conversion ratio were 67 per cent and 99 per cent respectively. Radiological examination showed pulmonary emphysema and generalized osteoporosis.

On the basis of these findings a diagnosis of hyperthyroidism was made and treatment with radioactive iodine was recommended.

On May 9, 1958, the patient was given an oral dose of 9 m.c. of I^{131}.

Total Body Radiation

The phrase "total body radiation" properly refers to a radiation dose homogeneous throughout the body. Since I^{131} is not distributed uniformly, the body dose is not homogeneous and hence the phrase is not strictly applicable. Nevertheless, one may determine the total dose received by the body per unit mass and the result, which is an average value over the body, is what is meant in this paper by total body radiation. Moreover, since radiation to the thyroid is the desired result of the treatment, we have not included thyroid radiation in our estimate. Total body radiation, in this sense, is due to beta and gamma radiation from I^{131} distributed throughout the extra-thyroidal space and from gamma radiation from I^{131} in the thyroid.

The following simplifying assumptions are made:

1. Excretion of I^{131} is entirely through the kidneys.
2. The I^{131} not yet excreted or decayed and not contained in the thyroid is uniformly distributed throughout the body.
3. The body is homogeneous and of density unity.
4. The beta radiation from I^{131} content is entirely absorbed within the body.

The procedure followed was to make frequent measurements of thyroid uptake and complete collections of urine over a 10-day period following administration of the therapeutic dose. The lower curve in Figure 1 is a plot of the uptake measurements corrected for decay. The upper curve in Figure 1 is obtained by subtracting from the administered dose the amounts of I^{131} excreted in the urine and corrected for decay. Thus the upper curve gives the total I^{131} in the body as a function of time and the lower curve gives,

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[3] *Research Fellow in Radiation Physics, University Hospital.*

as a function of time, the amount of this total which is resident in the thyroid gland. The difference between these two curves at any time is the amount of I^{131} present in the extra-thyroidal space.

The beta contribution to total body radiation is estimated from the I^{131} content in extra-thyroidal tissue. The gamma contribution is obtained with sufficient accuracy by taking the entire body content of I^{131} and supposing it to be uniformly distributed. By methods that are well known[2] the results obtained were

beta contribution	5.4 rads
gamma contribution	9.5 rads
Total body radiation (to the nearest whole number)	15 rads

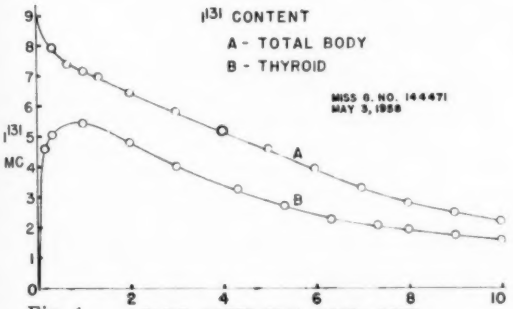

Fig. 1.

Radiation to the Ovaries

The following sources of radiation are considered:

(a) beta radiation from blood flowing through the ovaries
(b) gamma radiation from the thyroid
(c) gamma radiation from extra-thyroidal tissue
(d) gamma radiation from the bladder
(e) gamma radiation from the colon

(a) The beta dose to the ovaries.

In order to evaluate the beta dose to the ovaries it is assumed that blood flowing through the ovaries is the sole contributor; the activity in the blood is therefore obtained as a function of time. If the blood existed in a single reservoir, this information would then determine the total beta dose to the blood since then substantially all the beta energy would be absorbed in the blood. The diameter of vessels through which blood flows in the ovaries varies from capillary size to as much as 5 mm. in the larger vessels during ovulation and menstruation. Since 50 per cent of the beta radiation from I^{131} is absorbed in unit density material within about 0.4 mm. of its origin it follows that a substantial fraction of the beta energy will be absorbed in the blood — not the ovaries — except in the case of the smallest vessels. In order that the estimate shall be an upper limit it is assumed that all the beta energy originating in blood passing through the ovaries is, in fact, absorbed by the ovaries. Finally it is assumed that one-third of the total ovary volume is made up of blood.

The procedure is then to determine the beta dose to the blood supposing that all beta energy originating in the blood is absorbed by the blood and reckon that one-third of this is received by the ovaries.

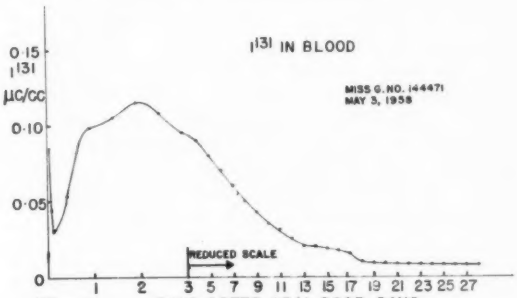

Fig. 2.

Following administration, samples of blood were drawn at 30 minute intervals for the first four hours and thereafter at 12 hour intervals for 28 days. In each case a 2 cc sample was counted against a 1/1000 μc standard in a well crystal. The result is shown in Figure 2.

From Figure 2 it is easy to calculate that the beta dose to the blood is 9.2 rads and one-third of this is taken as the beta dose to the ovaries, namely, 3 rads.

(b) The gamma dose to the ovaries from I^{131} in the thyroid.

The thyroid is treated as a point source of gamma rays with, however, 5 per cent of the gamma energy being lost due to self-absorption in the gland. The absorption coefficient for I^{131} gamma rays in tissue is taken to be 0.03 cm^{-1} and the distance from the thyroid to ovaries to be 35 cm. With these data and using the lower curve in Figure 1 the gamma contribution to the ovaries from I^{131} in the thyroid is found to be 0.6 rad.

(c) The gamma dose to the ovaries from I^{131} in extra-thyroidal tissue.

By methods that are well-described elsewhere[2] the gamma contribution to the ovaries from extra-thyroidal tissue is estimated to be 5 rads.

(d) The gamma dose to the ovaries from I^{131} in the bladder.

The bladder is considered as a sphere delivering radiation to the ovaries which are regarded to be at a fixed point 7 cm. from the centre of the bladder. For five days urine collections were made over successive eight-hour periods. Since the bladder content fluctuates irregularly it is necessary to make approximations so that calculations can be made. The bladder volume is considered to be zero during the first half of each eight-hour period and equal to the size of the eight-hour urine sample during the second half of the period. By measuring the activity of each urine sample and using the appropriate methods[2] a dose to the ovaries of 0.3 rad for the five-day period is obtained. The total dose from the bladder would be somewhat greater than this since the urine activity was not zero at the end of five days. The total bladder contribution to the dose is small, however, so an extrapolation is good enough. This extrapolated value is 0.5 rad.

(e) The gamma dose to the ovaries from I^{131} in the colon.

Fecal excretion was collected during the five days following administration and each sample was assayed for I^{131} content by comparison with a known source of comparable volume in a container of similar shape to that containing the sample. In order to estimate the effect of this iodine on the ovaries it is supposed that it is all concentrated in a two-cm. sphere 7 cm. from the ovaries but only during the third day of the five-day period. The total activity collected is then reckoned as at 2.5 days after administration. The method referred to in (d) above is used and a five-day dose of 0.2 rad is obtained. Extrapolation gives the full-term dose as 0.3 rad.

The total dose to the ovaries is the sum of the doses from all five sources, namely,

(a) beta radiation from blood	3
(b) gamma radiation from the thyroid	0.6
(c) gamma radiation from extra-thyroidal tissue	5
(d) gamma radiation from the bladder	0.5
(e) gamma radiation from the colon	0.3
	9.4 rads

To the accuracy allowable the total is 9 rads. It is fortuitous that this turns out to be 1 rad per m.c. of administered dose but it is believed this is of the right order of magnitude in this case.

Myant[6] has calculated the dose to the gonads in males and females and in both cases he obtained a result of 2 r per m.c. of I^{131} administered. This is in excess of our estimate. On the other hand, Bercy[1] arrived at a figure of 1.64 rad to the ovaries from a 10 m.c. dose of I^{131} which is only one-sixth of our estimate. This is at least partly explained by his assumed excretion of 45 per cent of administered dose within 12 hours. The measured excretion in our case was less than 10 per cent in the same time. Both of these papers intended to present general results. Our results are in terms of a single patient.

Discussion

The patient involved in this study was unusually light (73.5 pounds). The same dose to the thyroid of a heavier person could accomplish comparable thyroid therapy but would result in smaller total body radiation and a smaller dose to the ovaries. Thus the total body radiation of 1.7 rad per m.c. and the dose to the ovaries of 1 rad per m.c. is probably higher than would be the case with a more normal person. Nevertheless, this reservation does not dissipate the hazards associated with I^{131} therapy. The genetic hazard is of particular concern. When I^{131} therapy was first introduced there was a commonly accepted rule that limited its use to people over 40 years of age. Indications are that this rule has been somewhat relaxed recently. Of course, it is difficult to establish rigid rules. Every case must be judged on its own merits. Our view is that it would be unwise not to give total body radiation and genetic hazard their rightful place in this judgment.

Summary

There is increasing interest in total body radiation and dose to the gonads resulting from roentgen diagnostic procedures and from the use of radioisotopes. This paper deals with the administration of a 9-m.c. dose of I^{131} for hyperthyroidism to a 47-year old female patient of height 5'1" and weight 33.4 kg. Estimates were made of total body radiation (exclusive of dose to the thyroid) and the dose to the ovaries. The values obtained were respectively 15 and 9 rads.

Significant somatic damage is unlikely to result from this much total body radiation but the dose to the ovaries, which is chiefly of genetic significance, may be important.

It is suggested that the therapeutic use of I^{131} should proceed with due regard for the possible genetic hazard resulting.

The methods used in the analysis of this single case are being applied to a series of similar cases.

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GONADAL EXPOSURE DOSE TO ADULTS IN DIAGNOSTIC RADIOGRAPHY*

J. L. WOLFSON, Ph.D. and C. GARRETT, M.Sc.
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The knowledge that mutations can result from x-irradiation of the gonads has focussed attention on the problem of measuring and reducing radiation exposure of these regions. Of particular concern to the radiologist is the large fraction of gonadal exposure dose to the population as a whole due solely to exposure incidental to X-ray diagnostic procedures. Martin[1] has estimated that approximately one-half of the genetically significant exposure dose is due to this cause. General concern about this situation has manifested itself in the large amount of investigation undertaken in recent years, in many countries, with the aim of obtaining reliable data as to radiation to the gonads. Work has been accelerated within the last two years as a result of an invitation by the United Nations Scientific Committee on the Effects of Atomic Radiation, to the International Commissions on Radiological Protection (ICRP) and on Radiological Units and Measurements (ICRU), to consider this problem. An account of previous work on this subject, some of which forms part of the Commissions' report in 1957, is to be found in the works of Martin[1] and Larsson[2].

Surveys of the actual exposure doses received by patients undergoing radiological examination necessarily constitute the most valuable sources of reliable information. They do however have limitations. Ovary exposure dose, for example, is seldom measured directly. Moreover, the results of such surveys do not yield information as to the variation in gonadal exposure dose with changes in such factors as T.F.D. (target-film distance), filtration, field size, etc. They are designed solely to answer the question: "What is the gonadal exposure dose to the population as a whole due to medical x-ray diagnosis at the present time?"

Methods of reducing the exposure dose have been suggested, and are coming into practice. Shielding of the gonads is one obvious method, but limited in its applicability, particularly with females. The employment of modern techniques such as image amplification, and use of faster films in radiography, bid fair to reduce gonadal dose as a consequence of overall reduction in exposure dose. Quite apart from these innovations the possibility exists that gonadal dose in conventional radiography may be reduced by an informed choice of technique. Given several equally satisfactory techniques, the choice could then be made on the basis of minimum gonadal dose. The present work is concerned solely with the way in which gonadal exposure dose varies with those factors normally subject to choice in practice: T.F.D., field size, kvp. (peak kilovoltage), and added filtration. It is hoped that scope exists for a general reduction in gonadal dose by selection of appropriate techniques, and that the measurements reported below will constitute a useful guide in developing such techniques.

The results of the investigation are too extensive to be given in their entirety in this report. They are presented in 46 tables, a list of which is given below. The complete set of tables is published as#. Copies of this may be had upon application to the authors. In the present paper, Tables 1, 2 and 4 are shown as representative samples.

Scope of the Work

The measurements are applicable to adults undergoing radiography. The radiographic views taken are indicated in Figure 1. The number and types are by no means exhaustive. It will be noted that radiographs of the extremities have not been investigated, for the reason that with almost any technique they should contribute negligibly to gonadal exposure dose. Quite apart from the extremities, however, the variety of radiographic views is normally so great as to render a thoroughly complete investigation so time consuming as to be virtually impossible of accomplishment. It is believed however that the 19 views chosen encompass the vast majority of the work in diagnostic radiography which contributes significantly to the gonadal dose.

Measurements were made at five values of kvp: 50, 60, 70, 80 and 90, and up to four values of added aluminum filtration: 0, 1, 2, and 3 mm. of aluminum. Three values of target-film distance were employed: 30″, 36″, 40″, and up to three values of field size (at the position of the film): 8″ x 10″, 11″ x 14″, 14″ x 17″.

All measurements, applicable to both males and females, were made using a single Mix D phantom of a male of height 5 feet 9

* *Presented at Annual Meeting, The Canadian Association of Radiologists January 11-14, 1959, Saskatoon.*

Gonadal Exposure Dose to Adults in Diagnostic Radiography" by J. L. Wolfson and C. Garrett, X-Rays and Nuclear Radiations Laboratory, Division of Applied Physics, National Research Council of Canada, Ottawa, Canada. N.R.C. No. 5377.

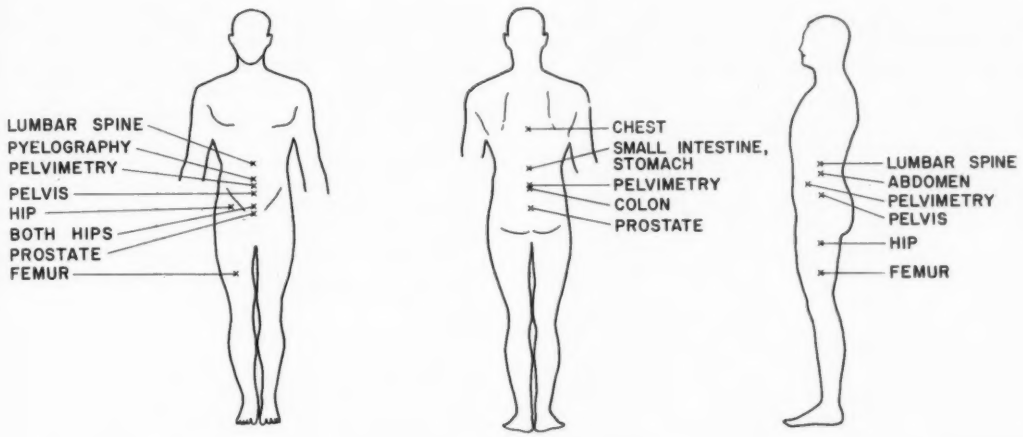

Figure 1 — Radiographic views, with positions of central rays indicated for A.P. views on the left, P.A. views in the center and lateral views on the right. For the hip in the lateral view, the central ray was directed to the inside of the leg with film held against the left side of the body.

inches and weight 150 lbs. (On occasion bolus was added to achieve an increase in thickness of the irradiated member.) A photograph of the phantom is shown in Figure 2.

The measurements made were of gonadal exposure dose (testes, right and left ovary), and of skin exposure dose. The values reported in the tables are, firstly G, the gonadal exposure dose in mr. per 100 mas. integrated tube current, and secondly R, the ratio of the gonadal exposure dose in mr., to the skin exposure dose in r. In those A.P. or P.A. views in which the field is symmetrical with respect to the median plane, only one ovary measurement was taken and it was assumed that the dose at the other ovary was identical.

Apparatus

The X-ray set used was a Westinghouse full-wave rectified unit with an upper limit of about 100 kvp. Inherent filtration of the tube was 0.5 mm. of aluminum. While the measurements were made at nominal values of 50, 60, 70, 80 and 90 kvp. with 0, 1, 2, and 3 mm. of added aluminum filtration, it cannot be expected that the qualities of radiation from other sets will be identical even when the nominal values of kvp. and filtration are the same. It is recommended that application of the data to any other X-ray unit be done on the basis of corresponding H.V.L., interpolating when required. Nevertheless for qualitative information as to how gonadal exposure dose is likely to change for example by an increase in kvp. from 70 to 80 kvp., it will probably be sufficient simply to examine the tables.

The phantom used was for convenience sawn into sections as is evident from Figure 2. Holes 1″ in diameter were drilled into the

Figure 2 — The Mix D phantom and measuring instruments.

phantom, one from the abdomen (visible in Fig. 2) and one from the left side, to the position of the left ovary. These holes received the small (10 cc.) ionization chamber for ovary exposure dose measurements. In the A.P. and P.A. views the hole drilled in from the left side was used, in which case the hole drilled in from the abdomen was filled with bolus material. In the lateral

views, the ionization chamber was inserted in the hole drilled in from the abdomen, and the other hole filled with bolus material.

The larger chamber shown is a 40 cc. ionization chamber, used to measure skin exposure dose. Only one of the electrometers is shown in Figure 2. The other was an identical unit. The 40 cc. chamber is a commercial chamber* originally developed by Osborn and Burrows[3] for the purpose of measuring gonadal dose in a large scale survey in the U.K. The 10 cc. chamber was constructed since it was felt that the 40 cc. chamber was rather large, particularly for the measurement of ovary dose in the phantom. The characteristics of the 40 cc. chamber are given in detail by Osborn and Burrows[3]. The quality response of the 10 cc. chamber was determined using the N.R.C. standard free-air ionization chamber and is shown in Figure 3. In this respect the large chamber is markedly superior to the 10 cc. chamber. Uniform response has however been assumed for both chambers over the entire range of qualities employed. The error introduced by this assumption is less than 12%. The contribution of this error to the total uncertainty is discussed below.

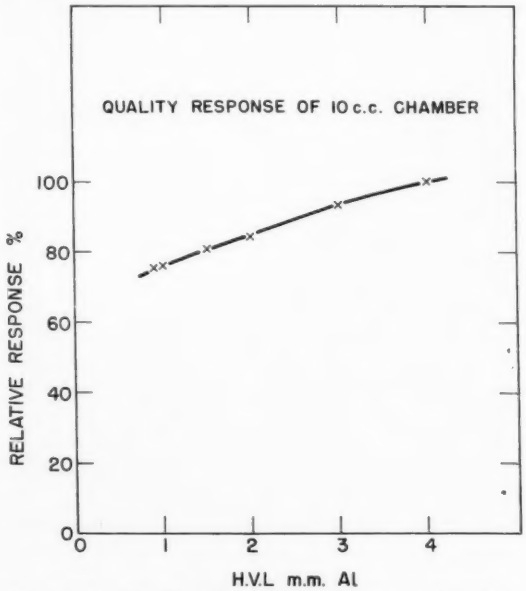

Figure 3 — Quality response of the 10 cc. chamber.

The response of the 10 cc. chamber as a function of direction of the X-rays relative to the axis of the chamber is shown in Figures 4 and 5. It is seen that the response does not fall off seriously until the X-rays come very close to entering the chamber through the cable end. For the purposes of the measurements it was assumed that the response of the chamber was isotropic with respect to direction of the X-rays. In all measurements however care was taken to orient the chamber so that it occupied a position of maximum or near maximum sensitivity relative to the source of radiation, whether primary or scattered. Under these conditions errors of no more than a few percent are introduced by the dead region near the cable end of the chamber.

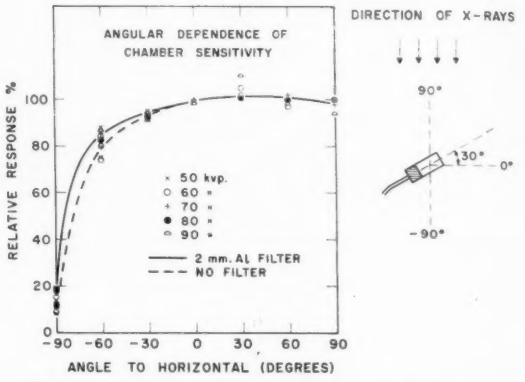

Figure 4 — Angular dependence of chamber sensitivity (10 cc. chamber).

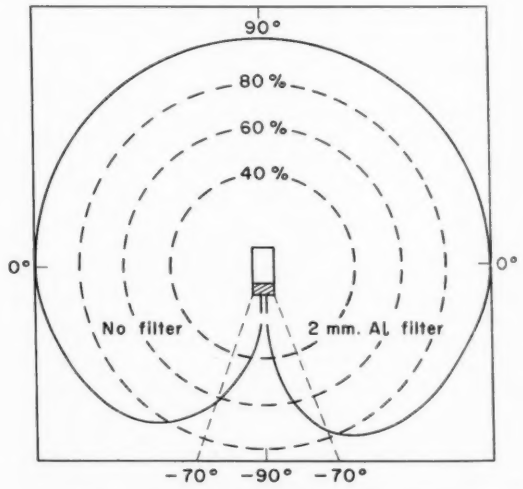

Figure 5 — Polar diagram of chamber sensitivity (10 cc. chamber).

In the work of Osborn and Burrows[3] it is demonstrated that for the 40 cc. chamber, saturation is effective up to very high exposure dose rates. At 2000 r/min the collection efficiency is greater than 95%. Although the gonadal dose chamber (10 cc.) is normally subjected to very low dose rates, saturation

* *This chamber, and the electrometers, are manufactured by Electronic Instruments, Limited, Richmond, Surrey, England.*

characteristics were nevertheless determined for this chamber, and it was demonstrated that collection efficiencies of greater than 99% were achieved over the entire range of exposure dose rates measured.

Method

Except for the chest, all views were taken with the phantom lying on the table. The field sizes used refer to the dimensions at the position of the film, and except in a few instances, the long dimension of the rectangular field was parallel to the long axis of the table. The procedure was to set the skin exposure dose chamber in the center of the field, lying on the surface of the phantom. The gonadal exposure dose chamber was placed at the position of the gonads. T.F.D. was then set at one of the three pre-determined values, and without added filtration, chamber readings were recorded at 50, 60, 70, 80, and 90 kvp., followed by a final reading at 50 kvp. Tube current of 50 ma. and exposure time of 1 sec. were employed for each exposure. Sets of readings were successively taken with added filtration of 1, 2, and 3 mm. of aluminum. The procedure was then repeated for the other two values of T.F.D. A correction was applied to the skin exposure dose to correct for the reading which would have been obtained had the chamber been half-submerged in the phantom material.

In positioning the central ray for all the views the authors were fortunate in being able to call upon the staff of the Radiology Department of the Ottawa Civic Hospital for advice. This advice was further supplemented by reference to standard works on this subject[4,5,6].

Accuracy of the Measurements

There are two major sources of error in the measurements. The first has to do with the physical apparatus. It has been pointed out above that neglect of a quality response correction for the 10 cc. chamber leads to an uncertainty due to lack of complete isotropy of the chambers with respect to the direction of the X-rays, which leads to an error of perhaps a few percent. For gonadal exposure doses of less than 1 mr, per 100 mas. a fairly substantial error enters due to difficulty in reading the small electrometer deflection. This error is estimated to be of the order of 15%, but depends on the magnitude of the deflection. For doses as low as 0.1 mr. the error may possibly be as large as 50-100%. On the other hand for doses larger than 1 mr. the error rapidly becomes small. There is also an uncertainty in the exposure time which has been found to be small. It is estimated that for exposure doses greater than 2-3 mr. per 100 mas. the uncertainty due to errors associated with the apparatus is about 15%. It should be pointed out that no attempt has been made to plot the tabulated results graphically, and to derive "smoothed" values. Consequently such experimental scatter as exists is inherent in the tabulated values.

The second source of error is associated with extrapolation of the data to human patients, and leads to much larger uncertainties which are difficult and at times impossible to estimate. The use of a phantom, (rather than a body), the variation in the position of the central ray, and the variation in the position of the ovaries, are the three factors giving rise to these uncertainties.

Despite the use of material approaching tissue-equivalence in construction of the phantom, the lack of bones may cause sharp differences between the actual gonadal exposure doses and those determined by measurement with the phantom. It may be expected however that the variation with kvp., added filtration, field size, and T.F.D. will follow much the same pattern in the phantom as in the body.

With regard to positioning the central ray, the authors suspect that differences in positioning may well exist among radiologists. Small variations in the position of the central ray can result in very large changes in the gonadal exposure dose. Extreme variations will of course be observed when the gonads lie near the edge of the field. In order to arrive at some estimate of the variation, a set of measurements was made of the male gonadal exposure dose for the A.P. lumbar spine view, with the central ray first positioned normally and then moved successively one inch toward the head and one inch toward the feet. The results are shown in Table 1. It is seen that the gonadal exposure dose can be approximately halved, or doubled, as compared with that measured in the normal position. It must be borne in mind that an even greater variation is to be expected when the field is closer to the gonadal region. Conversely the effect may be practically negligible for more distant fields, as, for example, the chest.

Variation of ovary position from patient to patient can also result in large discrepancies between values measured in the phantom and actual values. The authors can offer little in the way of a realistic estimate as to the extent to which the measurements herein reported are affected by the normal variation in ovary position. The problem would appear to require a separate investigation, coupled with fairly extensive information as to the actual variations in ovary position.

Discussion of the Results

The results of the measurements are presented in Tables 1 to 46. In general it is felt that little comment is required. There are however two points of interest which may be mentioned. It has become common recently to use 2 and even 3 mm. of added aluminum filtration on most diagnostic units in order to reduce skin exposure dose. The tables show that increasing filtration also leads to lower gonadal exposure dose at fixed mas., but that the ratio of gonadal to skin exposure dose increases. Consequently from the point of view of minimizing gonadal exposure dose, whether or not it is advantageous to use moderate filtration depends upon whether it becomes necessary to increase exposure time and by how much. If no increase in exposure time is required, then of course an overall advantage exists in using moderate filtration.

An apparent anomaly observed in several of the tables is that gonadal exposure dose under some circumstances is higher than skin exposure dose. This occurs for the male, when the gonadal chamber lies in the field of radiation, and is due to the fact that in these cases the gonadal chamber is surrounded by tissue to a greater extent than is the skin chamber. Accordingly while both chambers receive approximately the same amount of direct radiation, the gonadal chamber receives a larger contribution of scattered radiation.

ACKNOWLEDGMENT: The authors wish to thank Dr. Stoddart, and Miss J. Griffith of the Department of Radiology, Ottawa Civic Hospital for their advice in choice of radiographic views, and Mr. K. Hall for his help in positioning the central ray. Acknowledgment is also made of the loan of the 40 cc. ion chamber and associated electrometer by Dr. P. M. Bird of the Department of National Health and Welfare.

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46	Chest	P.A.	Female

* *In the present work, only Tables 1, 2 and 4 are given, as representative samples. The complete set of tables may be obtained upon application to the authors.* *See page 60.*

In the tables the symbols employed have the following meanings:

R — ratio of gonadal exposure dose in mr. to skin exposure dose in r.

G — gonadal exposure dose in mr. for 100 mas. at the kvp. listed, for full wave rectification, or at the corresponding H.V.L. (see below).

H.V.L. — half value layer in mm. of aluminum (exclusive of inherent filtration).

T.F.D. — target-film distance in inches.

Field size — dimensions of a rectangular field, given in inches, at the position of the film.

Filter thickness is given in added mm. of aluminum.

Thickness refers to thickness of the irradiated part or member and is given in cm.

Bolus material thickness is given in centimeters.

The long dimension of the field, unless otherwise noted, is lengthwise with respect to the table.

Half value layers corresponding to kvp. of 90, 80, 70, 60, 50, and added filtration of 0, 1, 2, 3 mm. of aluminum are as follows:

Filter	kvp				
	50	60	70	80	90
0	0.65	0.78	0.80	0.92	0.98
1	1.15	1.40	1.55	1.63	1.96
2	1.55	1.98	2.40	2.72	3.00
3	1.82	2.34	2.85	3.35	3.85

Table 1: Lumbar spine — A.P. — Male
Variation with position of central ray
Thickness — 17 cm.
Filter — 2 mm. added Al.

Field Size		8 x 10			11 x 14			14 x 17		
		G	H/G	F/G	G	H/G	F/G	G	H/G	F/G
T.F.D.	kvp.									
	50	0.15	0.60	2.0	0.22	0.33	3.0	0.51	0.57	2.7
	60	0.29	0.55	2.8	0.80	0.54	2.0	1.5	0.52	2.3
30	70	0.80	0.54	1.9	1.6	0.54	2.2	5.1	0.62	2.2
	80	1.4	0.58	2.0	3.1	0.57	2.0	6.3	0.62	1.8
	90	2.4	0.63	2.0	5.6	0.55	1.8	11.	0.64	1.9
		Means:	0.58	2.1		0.51	2.2		0.59	2.2
	50	0.72	0.70	1.1	1.3	0.56	1.5	1.4	0.53	1.6
	60	1.4	0.69	1.2	2.6	0.56	1.5	2.8	0.53	1.5
36	70	2.3	0.72	1.1	4.5	0.58	1.5	4.5	0.55	1.6
	80	3.2	0.75	1.3	6.8	0.61	1.5	6.8	0.56	1.6
	90	4.9	0.71	1.3	11.	0.60	1.6	10.	0.62	1.6
		Means:	0.71	1.2		0.58	1.5		0.56	1.6
	50	0.44	0.67	1.0	1.0	0.75	1.4	1.5	0.76	1.3
	60	0.65	0.89	1.2	1.9	0.88	1.3	2.9	0.73	1.4
40	70	1.1	0.80	1.3	3.4	0.72	1.3	4.7	0.74	1.4
	80	1.6	0.91	1.3	5.2	0.72	1.3	7.6	0.70	1.3
	90	2.3	0.78	1.3	7.5	0.73	1.4	11.	0.72	1.5
		Means:	0.81	1.2		0.76	1.3		0.73	1.4

G — gonadal exposure dose in mr. per 100 mas.
H — gonadal exposure dose with central ray moved 1" toward head.
F — gonadal exposure dose with central ray moved 1" toward feet.

Table 2: Lumbar Spine — A.P. Male Thickness — 17 cm.

Field Size		8 x 10								11 x 14								14 x 17							
Filter		0		1		2		3		0		1		2		3		0		1		2		3	
		R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G
T.F.D.	kvp.																								
	50	0.1	0.2	0.2	0.1	0.3	0.1	0.3	0.1	0.3	0.6	0.5	0.4	0.6	0.3	0.8	0.3	0.5	1.1	0.8	0.6	1.3	0.5	1.3	0.5
	60	0.1	0.5	0.3	0.4	0.4	0.3	0.4	0.3	0.4	1.2	0.7	0.9	1.1	0.8	1.5	0.8	0.7	2.2	1.3	1.7	1.8	1.4	2.0	1.3
30	70	0.2	1.0	0.3	0.7	0.5	0.7	0.8	0.7	0.5	2.2	1.0	2.0	1.6	1.7	1.6	1.6	1.0	4.3	1.7	3.1	2.6	3.0	2.8	2.9
	80	0.3	1.7	0.6	1.4	0.8	1.4	1.0	1.3	0.7	3.9	1.2	3.1	1.9	3.1	2.1	3.1	1.4	7.1	2.4	6.0	3.6	5.9	3.7	5.4
	90	0.4	2.8	0.8	2.5	1.1	2.3	1.2	2.3	1.0	6.8	2.0	6.6	2.6	5.9	2.9	5.4	1.7	11.	3.2	10.	4.3	9.6	4.7	9.5
	50	0.3	0.3	1.1	0.4	2.5	0.5	2.8	0.5	0.5	0.6	2.0	0.8	4.3	0.9	4.4	0.8	0.9	1.2	3.8	1.9	6.2	1.8	6.9	1.7
	60	0.2	0.4	1.2	0.9	2.2	0.9	2.8	0.9	0.6	1.0	2.2	1.6	4.1	1.7	4.6	1.6	1.2	2.3	4.1	3.6	6.4	3.2	7.0	3.1
36	70	0.3	0.8	1.2	1.3	2.5	1.6	3.1	1.7	0.8	1.9	3.0	2.8	4.8	2.8	5.1	2.8	1.5	3.9	4.5	5.7	7.1	5.2	7.9	5.2
	80	0.4	1.2	1.7	2.1	2.7	2.5	3.0	2.5	1.0	3.2	2.9	4.2	4.8	4.5	5.4	4.4	1.8	5.8	5.1	8.1	7.8	8.6	8.5	8.4
	90	0.5	1.9	1.5	2.8	2.8	3.6	3.1	3.6	1.5	5.4	3.3	6.6	5.5	7.0	6.3	7.1	2.3	9.1	5.5	12.	8.0	12.	8.8	12.
	50	0.3	0.2	1.6	0.4	2.4	0.4	2.7	0.4	1.0	0.9	3.3	1.2	6.3	1.2	8.2	1.0	2.8	2.6	8.4	2.3	7.9	1.4	14.	1.8
	60	0.3	0.4	1.6	0.9	2.3	0.8	3.0	0.8	1.7	2.1	4.1	2.2	7.2	2.1	8.2	2.0	3.4	4.5	8.2	4.2	12.	3.9	15.	3.6
40	70	0.4	0.8	1.9	1 4	3.0	1.4	3.3	1.4	1.7	2.8	4.5	3.5	8.0	4.7	8.9	4.1	4.4	7.3	9.5	7.5	13.	7.0	14.	6.3
	80	0.6	1.3	2.1	2.1	2.9	2.1	3.3	2.1	1.9	4.1	4.7	5.3	7.3	5.2	8.4	5.2	4.9	11.	11.	12.	15.	11.	16.	10.
	90	0.7	2.0	2.1	2.8	3.4	3.1	3.8	3.1	2.4	6.7	5.3	7.7	8.6	8.1	9.9	8.1	5.9	16.	11.	17.	17.	16.	21.	16.

Table 4: Lumbar Spine — A.P. — Female Thickness 17 cm.

Field Size		8 x 10								11 x 14								14 x 17							
Filter		0		1		2		3		0		1		2		3		0		1		2		3	
		R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G	R	G
T.F.D.	kvp.																								
	50	1.2	2.9	2.7	2.4	4.0	1.9	4.4	1.8	8.3	20.	17.	16.	24.	12.	25.	11.	37.	91.	85.	72.	89.	43.	87.	39.
	60	2.3	8.2	4.8	7.0	7.1	6.0	7.6	5.7	14.	46.	25.	38.	35.	32.	37.	29.	54.	190.	98.	140.	120.	110.	140.	100.
30	70	3.5	16.	6.9	15.	10.	13.	11.	13.	19.	94.	36.	78.	46.	67.	49.	62.	71.	340.	120.	270.	160.	220.	170.	200.
	80	5.1	30.	7.6	22.	13.	24.	14.	24.	25.	150.	44.	130.	59.	120.	65.	110.	90.	540.	150.	440.	190.	380.	200.	350.
	90	6.9	51.	12.	30.	16.	41.	18.	40.	63	250.	56.	210	69.	190.	73.	180.	110.	810.	170.	690.	230.	600.	230.	560.
	50	3.1	4.0	3.8	2.0	7.7	2.0	9.0	2.0	40.	51.	73.	38.	105.	31.	110.	27.	44.	60.	83.	43.	110.	31.	120.	28.
	60	5.5	11.	9.6	8.0	14.	7.0	16.	6.5	62.	120.	100.	87.	140.	73.	150.	66.	64.	130.	120.	100.	150.	77.	160.	69.
36	70	9.1	24.	16.	19.	20.	15.	22.	14.	80.	210.	140.	180.	180.	150.	190.	130.	85.	230.	150.	190.	190.	150.	200.	110.
	80	12.	43.	21.	36.	26.	28.	29.	27.	110.	340.	170.	280.	210.	240.	220.	220.	110.	380.	170.	300.	220.	250.	230.	240.
	90	16.	70.	25.	56.	33.	52.	36.	49.	120.	520.	200.	430.	250.	380.	260.	360.	130.	570.	200.	460.	250.	400.	260.	370.
	50	2.0	2.0	2.7	1.0	5.4	1.0	6.3	1.0	44.	42.	82.	29.	110.	21.	120.	19.	52.	49.	97.	36.	130.	28.	130.	25.
	60	4.2	6.0	8.4	5.0	11.	4.0	13.	4.0	64.	97.	110.	65.	140.	53.	160.	49.	78.	110.	150.	88.	190.	69.	200.	62.
40	70	7.3	14.	12.	11.	12.	9.0	18.	8.5	77.	160.	150.	130.	190.	110.	190.	99.	100.	200.	170.	160.	230.	130.	240.	120.
	80	9.4	24.	17.	20.	17.	18.	24.	16.	110.	260.	180.	220.	220.	180.	230.	170.	130.	320.	200.	260.	270.	220.	280.	200
	90	13.	40.	21.	34.	21.	32.	31.	30.	130.	380.	210.	240.	250.	290.	260.	270.	150.	460.	250.	420.	310.	350.	330.	330.

LYMPHOMA OF THE G. I. TRACT *

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It has become apparent that primary lymphoma of the G. I. Tract carries a much more favorable prognosis than carcinoma. For this reason it is important that we be familiar with the features of this disease, particularly with the evidence that will help us to make the diagnosis preoperatively.

This paper reports an analysis of all cases of lymphoma that were investigated in the Clinics of the Saskatchewan Cancer Commission in the years 1940 - 1958 inclusive in which there was involvement of the gastro-intestinal tract. This group of patients includes those in which the gastro-intestinal tract involvement was primary and those in which it was part of a more generalized process. It excludes those in which the involvement was primarily in neighboring organs or lymph nodes.

652 cases have been reviewed of which 52 had intrinsic involvement of the stomach. In 25 of these the process was primary in the stomach while in 27 it was part of a generalized involvement of the lymphatic system. In all cases, the diagnosis has been confirmed pathologically as to diagnosis, and in most cases as to locality as well. Of the 52 patients, lymphomatous involvement of the stomach had been suspected clinically in only 4 while the diagnosis of a malignant lesion had been made in 20.

The small bowel was involved in 31 cases and the large bowel in 21 cases. In addition to these, there was one case in which there was involvement of the esophagus from neighboring involved lymph glands.

Most authors stress the higher incidence of lymphoma of the G. I. Tract in young adults as compared with carcinoma. This point therefore forms a valuable diagnostic feature. Our study confirms this higher incidence. 30.3% of the cases of lymphoma of the stomach appeared in the 3rd and 4th decades as shown in Table 1. In a series of 1400 cases of carcinoma of the stomach seen during the same period, only 4.1% of the cases occurred in the 3rd and 4th decades. The age distribution of the 25 cases with primary involvement of the stomach is similar. 28% of these occurred in the 3rd and 4th decades. A study of the age incidence of cases with small intestine involvement reveals the same tendency. In this group

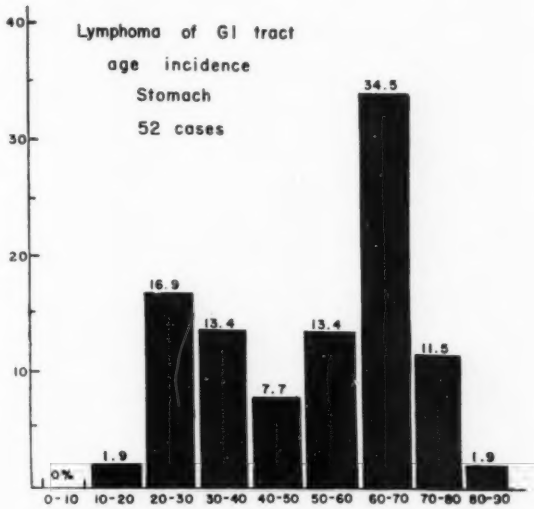

Table 1 — Age incidence of 52 cases of lymphoma of stomach showing 30.3% of cases occurring in the third and fourth decades.

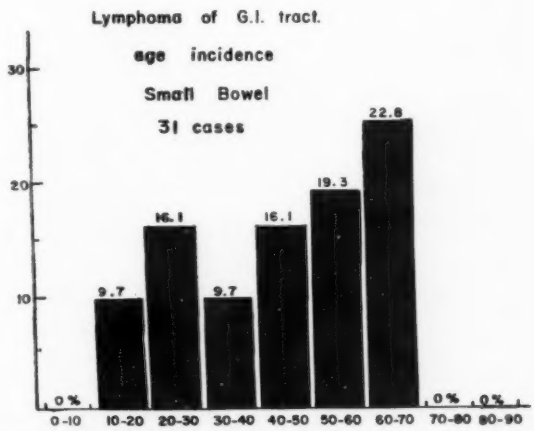

Table 2 — Age incidence of 31 cases of small bowel involved by lymphoma showing 25.8% of the cases occurring in the third and fourth decades.

25.8% occurred in these decades. (Table 2.) In the large bowel, 28.5% of the cases occurred in this age group as shown in Table 3. This study therefore confirms the reported higher incidence of the disease in younger age groups than is the case with Carcinoma.

The sex incidence of this group of cases is similar to the reported sex incidence which ranges between 7 - 1 and 1.6 - 1 in favor of males. In our series, we found a male predominence of 5.3 - 1 for stomach; 2.1 - 1 for small bowel and 2.8 - 1 for large bowel.

*Presented at 22nd Annual Meeting, January 11th—14th, 1959, The Canadian Association of Radiologists, Saskatoon, Sask.

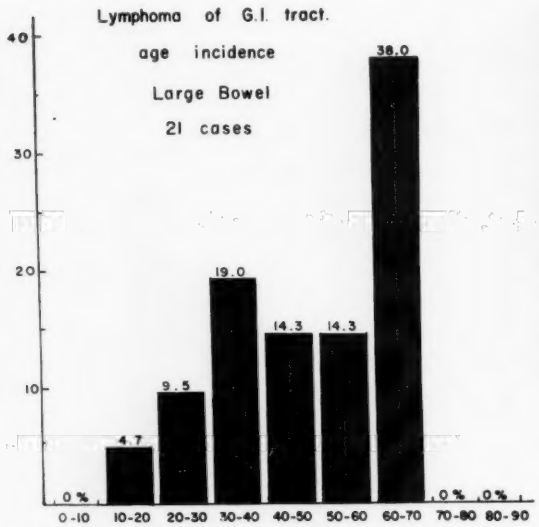

Table 3 — Age incidence of 21 cases of large bowel involvement by lymphoma showing 28.5% of cases occurring in the third and fourth decades.

The radiological features of gastric lymphoma can be divided into three main groups, (a) those in which there was a polypoid filling defect, (b) those in which there was an infiltrating defect with or without ulceration and (c) those in which there was a generalized accentuation of the mucosal pattern. Polypoid filling defects were usually large and extensive occupying much of the lumen of the stomach, with small collections of barium outlining the lobulations of the tumor. There was no definite predilection for a particular portion of the stomach. Ten of the patients with stomach involvement had polypoid growths similar to the example shown in Figure 1. Infiltrating defects were identical with carcinomatous lesions and presented no characteristic radiological features except that the lesions were usually large when first identified and out of proportion to the clinical status of the patient. The lack of pyloric obstruction, even in extensive lesions is a valuable feature. Of ten cases with infiltrating lesions, only one had obstructive features. Figure 2 is an example of this type of infiltrating growth. Ulcers were characteristically large and deep with rolled edges and steep sides. They were usually situated centrally in an infiltrative lesion and the mucosal pattern in the surrounding portion of the stomach was usually lost. Such a case is shown in Figure 3. Occasionally there were multiple ulcers. The cases with generalized accentuation of mucosal pattern usually revealed a wild exaggeration with slight or no distortion of the rugal folds. Usually there was some preservation of peristaltic activity and pliability. These fea-

Figure 1 — Polypoid involvement of the stomach by lymphoma showing a large lobulated growth with barium in the crevices occupying the lower two-thirds of the stomach.

Figure 2 — Infiltrating lymphoma of the stomach showing extensive invasion of the lesser curve.

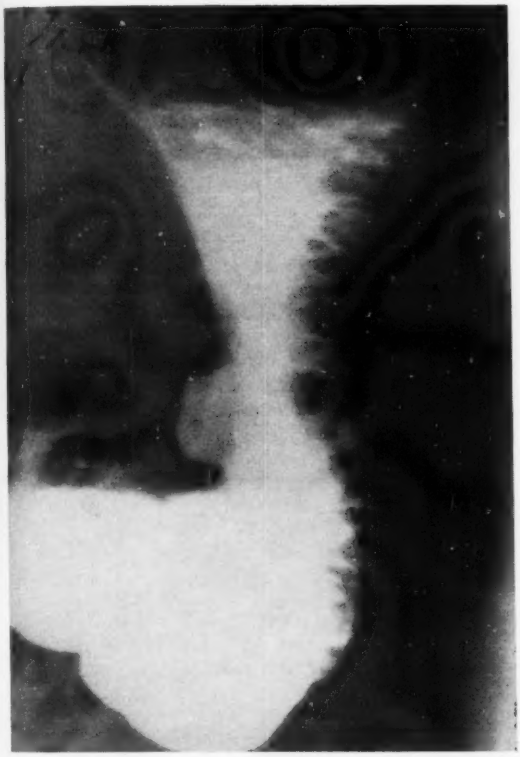

Figure 3 — An example of the characteristically large and deep ulcer seen in cases of lymphoma of stomach.

tures as shown in Figure 4 are considered by some to be the result of generalized submucosal infiltration by lymphomatous elements rather than localized replacement as found in the three preceding types.

While recognition of these features leads us to suspect the possibility of lymphoma of the stomach, none of them will allow a definite diagnosis to be made.

However the features to be seen in the region of the duodenal cap may be sufficiently characteristic to allow a firm diagnosis in some patients. It is a well known fact that carcinoma rarely crosses the pylorus to involve the duodenum. In this study however, there was extension of disease across the pylorus to involve the duodenum or to involve lymph glands in close association with the duodenum in ten patients. Radiologically, it may be difficult or impossible to establish whether deformity of the duodenal cap is due to involvement by the same process seen in the pyloric end of the stomach or whether it is due to post-peptic ulcer scarring and deformity. But, if one can convince oneself that deformity in the duodenal cap is of similar age to the gastric deformity or if it

Figure 4 — An example of the wild accentuation of the mucosal pattern found in cases in which the involvement is a generalized submucosal infiltration rather than localized replacement.

Figure 5 — An example of the duodenal changes which may be characteristic of lymphoma as opposed to carcinoma if they can be identified.

is of a type to allow exclusion of a peptic ulceration or its sequelae, we have a strong diagnostic point in favor of lymphoma. In most cases, the duodenal changes present were extrinsic in type but the changes were quite marked and extensive. As a rule, there was no great difficulty in differentiating the deformity from peptic ulcer deformity and establishing that extension had progressed across the pylorus. Minor extrinsic deformities of the duodenal cap as shown in Figure 5 or of the proximal descending duodenum or more gross invasion of the duodenum was present in 10 patients.

Patients with lymphomatous involvement of the small bowel usually present with a clinical picture of acute, sub-acute or recurring bowel obstruction. In many, the clinical problem is ushered in by intussusception which may spontaneously disappear only to recur in a few days or weeks. Subsequent barium studies may succeed in demonstrating a polypoid or an infiltrating growth and these will be found most frequently in the ileo-cecal region. The malabsorption type of small bowel disorder has been reported in patients with this disease but this feature was not demonstrated in any of our cases. Perforation of the bowel is also reported as a frequent phenomenon. This was so in 3 of our cases. It was interesting to note that the total number of malignancies of the small bowel seen during the period of this study was made up of exactly equal numbers of lymphomas and carcinomas. In 8 of our patients there was ileus of varying degree usually not marked or severe. In none was a diagnosis of lymphoma made at this stage of investigation. The usual feature of gas-distended bowel with fluid levels when appropriate positioning was employed was present in varying degrees. In 3 of these patients there was a bulky tumor (Figure 6) which was polypoid in nature. Two of these had shown some evidence of intussusception. However, in most instances spontaneous reduction took place, frequently with recurrence of the intussusception at a later date. In many instances the patient had an exploratory laparotomy which established a diagnosis before any barium studies were carried out. In 3 of our patients there was a tumor which was infiltrating in nature (Figure 7) and all of these were associated with some obstructive signs. This was of interest as in the stomach obstructive features were not impressive even when large tumors were present.

Lymphoid tumors of the large bowel present features which are indistinguishable from carcinoma. The tumor usually is polypoid and may be ulcerated. Intussusception is a frequent phenomenon here as in the small bowel. Obstructive features are not impressive unless an intussusception occurs. The polypoid tumors are often large and bulky (Figure 8) with barium outlining crevices in the tumor as well as in the folds of the intussusception. In one of our patients with large bowel involvement two lesions were present. The lower tumor was involving the rectum and was infiltrating and excavating. The remainder of the cases were all polypoid and some showed varying degrees of intussusception or evidence that intussusception had been present.

Figure 6 — An example of bulky polypoid tumour in lymphoma of the small bowel which may occasionally be demonstrated if a barium study can be carried out preoperatively. In many cases the obstructive features make this unwise.

Conclusions

Many of the features of lymphoma of the gastro-intestinal tract simulate features of carcinoma so closely that differentiation is difficult or impossible.. In view of the favorable prognosis in lymphoma when radical treatment is instituted, preoperative diagnosis is of great importance. Some of the features which will assist in making a preoperative diagnosis are:

1. A large, extensive malignant lesion in a young adult or a bulky tumor in a patient who appears to be in good general health.

2. In the stomach a large bulky or extensive tumor with or without large and deep ulcers or wild rugal pattern with preservation of some pliability and perhaps extension to the duodenum of a characteristic type.

3. In the small bowel, ileus or perforation may have a lymphomatous etiology and this possibility is greater if there has been an intussusception.

4. In the large bowel obstructive features are not prominent in spite of a bulky tumor shown by a barium study.

If we consider the possibility of lymphoma of the G. I. Tract when these features are present, more frequent preoperative diagnosis of this condition should be possible.

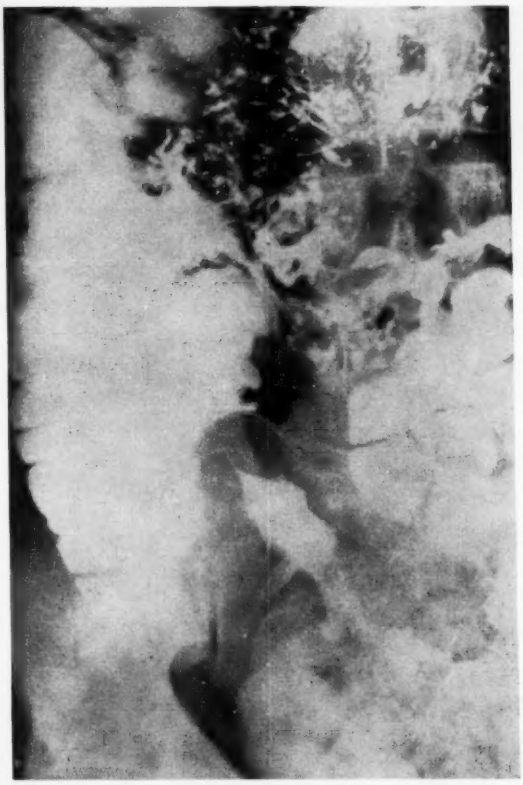

Figure 7 — An example of infiltrating lymphoma of the small bowel. These patients all had obstructive features of varying degree, a feature uncommon in the stomach and large bowel.

Figure 8 — An example of polypoid large bowel tumor due to lymphoma. Intussusception as seen here is common in these patients.

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ACKNOWLEDGMENTS : The author is indebted to Drs. E. W. Spencer, A. B. MacDonell and A. Becker in Saskatoon and Drs. A. E. Perry and H. P. Kent in Regina for use of their cases and to Dr. A. J. S. Bryant of the Allan Blair Memorial Clinic in Regina for permission to study his case material.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

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